(12) UK Patent Application (19) GB (11) 2 091 882 A

(54) **Electrical catalytic gas detection systems**

(57) Intermittent measurements of gas concentration are made using a "pellistor" or like catalytic sensing element while avoiding lengthy heating-up times. The resistor (17) of the element, serving both as heater and thermal sensor, is connected in a bridge network (ABCD) having an associated servo loop which controls current supplied to the network (ABCD) via a transistor (21). An operational amplifier (23) in the loop is switched from a quiescent state, when the network (ABCD) is substantially de-energised, to an active state, when sufficient current is supplied to heat the element to operating temperature, and subsequently back to the quiescent state after a steady state condition is reached wherein the servo loop operates to hold the element at constant temperature; a voltage appearing on an output line (Y) is sampled while that condition applies to provide the measurement. Compensation for ambient temperature variations is effected by means of a simple reference circuit incorporating a semiconductor diode. A system for the controlling the sequential operation of the system is disclosed, Figure 5 (not shown).
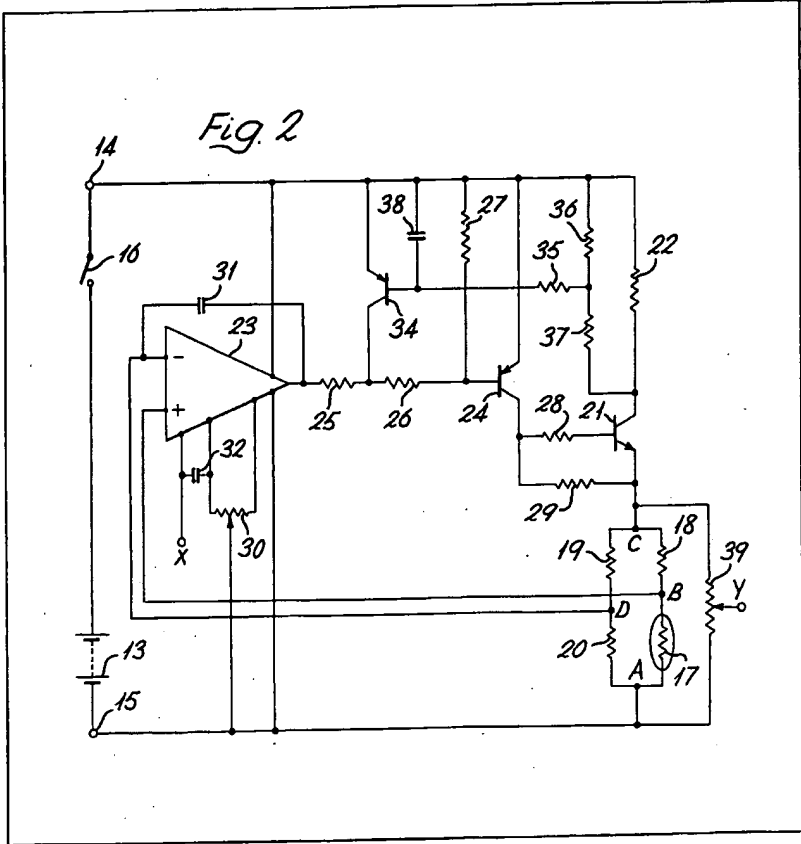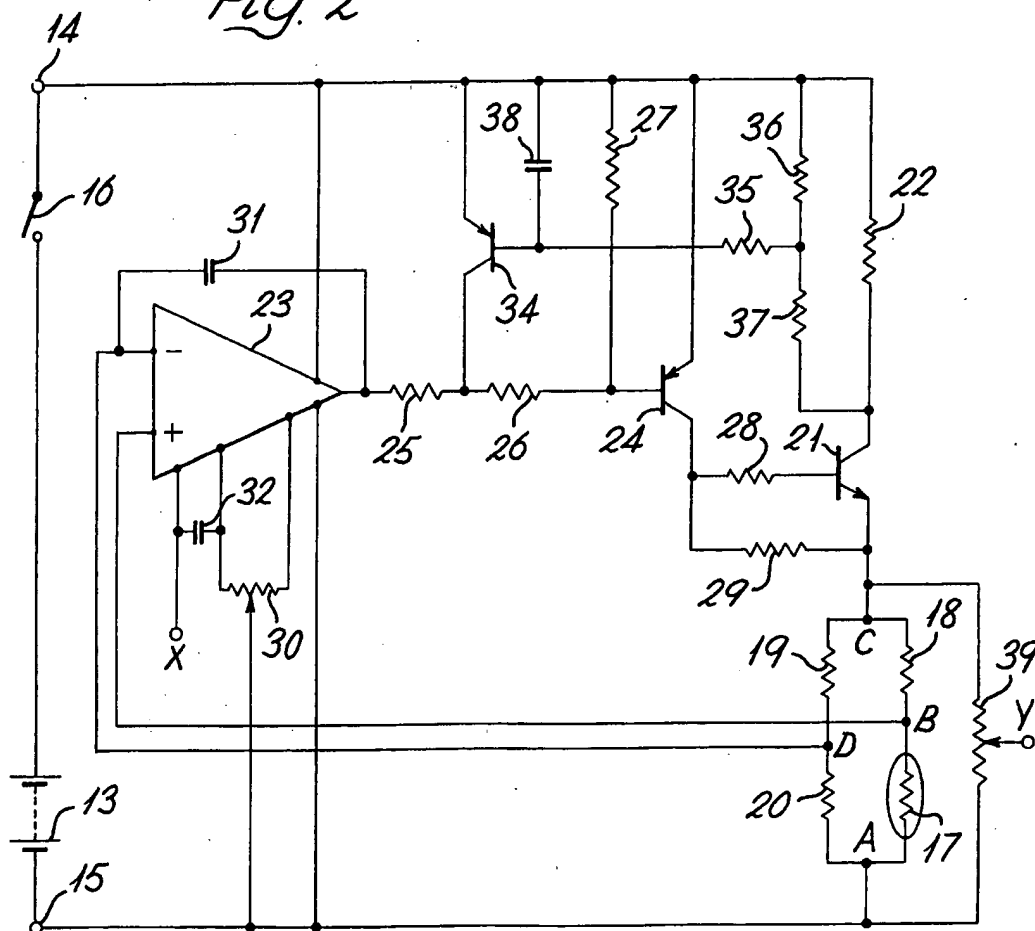
Fig. 2

GB 2 091 882 A

BEST AVAILABLE COPY

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

BEST AVAILABLE COPY
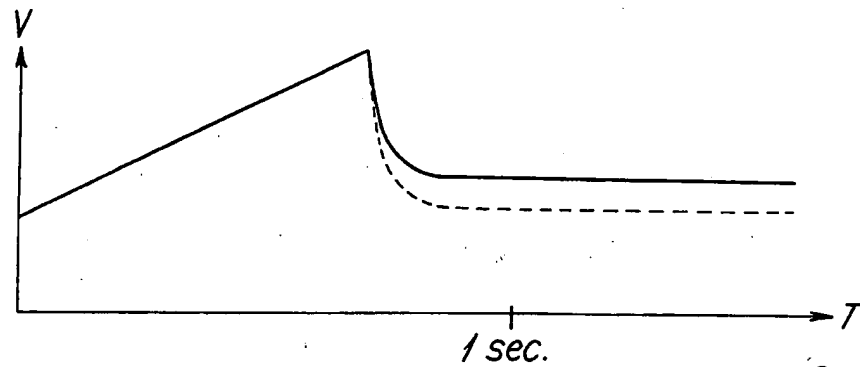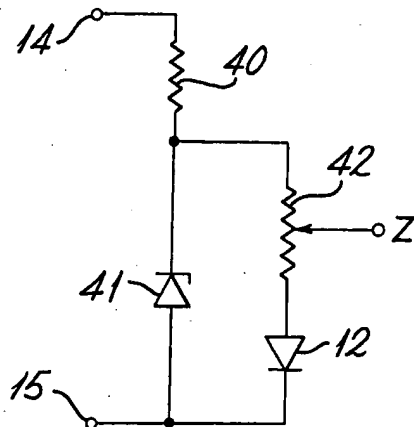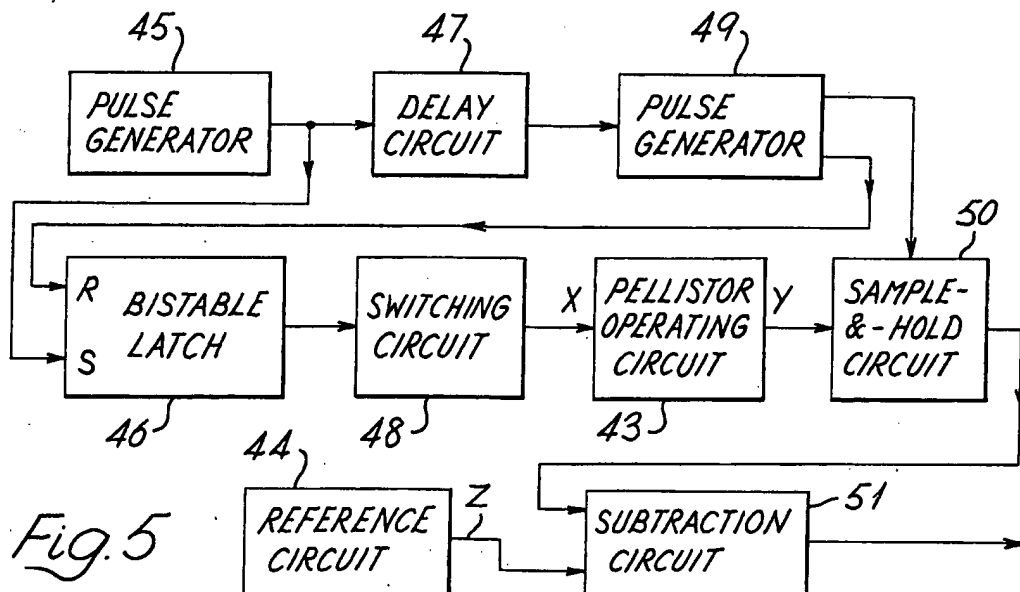
SPECIFICATION

Catalytic gas detection systems

5 This invention relates to gas detection systems of
the kind incorporating a sensing element which
embodies a catalyst material exposed for contact
with gaseous samples to be tested, the element
being at least partly constituted by a thermally
10 sensitive electrical resistor through which current is
passed to heat the catalyst material and which also
serves as a sensor responsive to the temperature of
the catalyst material. One form of sensing element
utilised in such systems consists simply of a wire of
15 platinum or a platinum-base alloy, which constitutes
both the catalyst material and the thermally sensitive
resistor; in an improved form of element, known as a
"pellistor" and described for example in British
Patent Specification No. 892,530, the catalyst mate-
20 rial is constituted by a surface coating or impregna-
tion of a pellet of refractory material within which is
embedded a coiled part of a wire which constitutes
the resistor.
  Gas detection systems of the kind specified are
25 primarily used for detection of combustible gases in
oxygen-containing atmospheres, but also have other
possible applications. They operate by virtue of the
sensing of thermal effects associated with the
occurrence on the catalyst material of at least one
30 reaction which is either participated in or influenced
by a specific gas to be detected. For this purpose it is
usual in such systems for the sensing element
resistor to be connected in a resistive bridge network
arranged to be supplied with current such that the
35 catalyst material will be heated to a temperature at
which the appropriate reaction(s) can occur, there
being derived from the network an output voltage
whose value is dependent on the relevant thermal
effects (and hence on the concentration in a test
40 sample of the gas or gases to be detected). The
conventional practice in this respect is to employ a
standard Wheatstone bridge arrangement so as to
detect directly changes in the resistance of the
sensing element resistor caused by the thermal
45 effects to be sensed, i.e. a source of nominally
constant voltage is connected between one pair of
diagonally opposed terminals of the bridge network
and the output voltage is derived from the other pair
of terminals of the network; to cater for possible
50 variations in parameters such as the ambient tem-
perature and the source voltage, it is normal with
this arrangement to provide a compensating ele-
ment similar in form to the sensing element but of a
non-catalytic nature, the sensing and compensating
55 elements being exposed as far as possible to the
same conditions and having their respective resis-
tors connected in adjacent arms of the bridge.
  A disadvantage of the standard Wheatstone
bridge arrangement is that it is not well adapted for
60 used in cases where it is desired to make only
intermittent measurements, under either automatic
or manual control. It is obviously desirable in such
cases to void unnecessary consumption of power by
de-energising the bridge between individual mea-
65 surements, but the snag then arises that when the

bridge is energised with the sensing element initially
in a cold state a significant time elapses before the
bridge reaches a steady operating condition in which
a reliable reading can be obtained; typically this time
70 is of the order of 10 seconds when the sensing
element is a pellistor. A further disadvantage of the
Wheatstone bridge arrangement using a compensat-
ing element is the need to match carefully the
sensing and compensating elements used in a
75 specific system.
  The present invention is based on the realisation
that an improvement in these respects can be
achieved if one adopts an alternative to the standard
Wheatstone bridge arrangement in which the cur-
80 rent supplied to the bridge network is automatically
controlled, in response to a feedback signal derived
from the network, so that a steady state operation
the resistance of the sensing element resistor is
maintained substantially constant (at a value corres-
85 ponding to the desired operating temperature of the
catalyst material), the output voltage being derived
from the network in such a way that its value is
dependent on the value of the current supplied to the
network; with this arrangement changes in the
90 resistance of the sensing element resistor that would
otherwise occur due to the thermal effects to be
sensed are counteracted by changes in the current
supplied to the network, which are in turn reflected
in changes in the output voltage. This type of
95 "constant temperature" arrangement has long been
known in principle, but appears to have found little
practical application in gas detection systems of the
kind specified. In particular there seems to have
been no appreciation hitherto of the advantages that
100 may be gained from the use of a constant tempera-
ture arrangement in respect of the factors discussed
above. As to the first of these, it has been found
possible when using a constant temperature
arrangement to achieve much lower values of the
105 heating-up time required to reach a steady operating
condition with a given type of sensing element than
is the case when using a standard Wheatstone
bridge arrangement. As to the second factor, it has
been found possible when using a constant temper-
110 ature arrangement to dispense with any need for a
compensating element similar to the sensing ele-
ment, by providing a simple form of compensation
for variations of ambient temperature, the constant
temperature arrangement itself being inherently
115 adapted to compensate for variations of supply
voltage.
  According to one aspect of the invention, there is
provided a gas detection system of the kind specified
in which said thermally sensitive resistor is con-
120 nected in a resistive bridge network arranged to be
supplied with current whose value is set by a control
means which can assume either a first state such
that sufficient current is supplied to the network to
cause the sensing element of the system to be
125 heated to an elevated operating temperature or a
second state such that the network is substantially
de-energised, the control means being operative in
said first state so that the system has a steady state
condition in which the value of the current is
130 automatically controlled by the control means, in

response to a feedback signal derived from the
network, so as to maintain the resistance of said
resistor substantially constant, the system compris-
ing means for causing the control means to change
5 from said second state to said first state and to revert
to said second state after a period during which the
system will reach said steady state condition, means
for deriving from the network an output voltage
whose value when the system is in said steady state
10 condition is dependent on the value of the current
supplied to the network, and means for obtaining a
measurement by virtue of the sampling of said
output voltage during the part of said period when
the system is in said steady state condition.
15   According to another aspect of the invention, there
is provided a gas detection system of the kind
specified in which said thermally sensitive resistor is
connected in a resistive bridge network arranged to
be supplied with sufficient current to cause the
20 sensing element of the system to be heated to an
elevated operating temperature, the system com-
prising a control means which is operative so that
the system has a steady state condition in which the
value of the current is automatically controlled by
25 the control means, in response to a feedback signal
derived from the network, so as to maintain the
resistance of said resistor substantially constant,
means for deriving from the network an output
voltage whose value when the system is in said
30 steady state condition is dependent on the value of
the current supplied to the network and hence is
subject to unwanted variation as a result of changes
in the temperature of the surroundings of the
sensing element, and means for obtaining a mea-
35 surement by virtue of the comparison of said output
voltage with a reference voltage derived from a
circuit which includes a semiconductor diode dis-
posed so as to be exposed to the temperature of said
surroundings, the diode having a temperature coeffi-
40 cient such that said unwanted variation in respect of
said output voltage is compensated for by corres-
ponding variation in the reference voltage.
   One gas detection system in accordance with the
invention will now be described by way of example
45 with reference to the accompanying drawings, in
which:-
   Figure 1 is a part sectional view of a sensing head
forming part of the system;
   Figure 2 is a diagram of a pellistor operating circuit
50 incorporated in the system;
   Figure 3 is an explanatory diagram;
   Figure 4 is a diagram of a reference circuit
incorporated in the system; and
   Figure 5 is a block diagram illustrating the overall
55 electrical arrangement of the system.
   The system to be described is intended for the
detection of methane in air at concentrations up to
5%, and is designed to enable measurements of
methane concentration to be made on an intermit-
60 tent basis, either at the will of an operator (as would
be appropriate in a portable instrument for making
spot tests) or at regular intervals under automatic
control (as would be appropriate in an instrument for
"continuous" monitoring).
65   Referring to Figure 1, the system includes a

sensing head incorporating a metal block 1 through
which extends a cylindrical passage 2 communicat-
ing with inlet and outlet pipes 3 and 4. Formed in the
block 1 is a cylindrical cavity 5 which extends from
70 the top of the block 1 to meet the passage 2; the
inner end of the cavity 5 is covered by part of a
tubular member 6 of metal gauze which fits closely
within the passage 2. Within the cavity 5 is disposed
a pellistor 7 (Type VQ3), the ends of the wire which
75 constitutes the thermally sensitive resistor of the
pellistor 7 being respectively attached to support
wires 8 and 9 which form part of a header of a type
commonly used in semiconductor devices; the
header is held in place by a cap 10 so as to cover the
80 outer end of the cavity 5. Also formed in the block 1
is a cavity 11 within which is disposed a silicon diode
12 (Type BAX13) arranged in good thermal contact
with the metal of the block 1. In operation of the
system a stream of gas drawn from an atmosphere
85 to be monitored is pumped through the passage 2,
and gas from this stream diffuses through the
member 6 into the cavity 5 so as to reach the
pellistor 7; with the pellistor 7 at an appropriate
temperature (suitably in the range 550 - 600°C), the
90 presence of methane in the gas reaching it will give
rise to a heating effect on the pellistor 7 due to the
combustion of methane brought about by the
catalyst material. The pumping may be either con-
tinuous or intermittent, as appropriate to the particu-
95 lar type of instrument involved; in the latter case it is
of course necessary before a measurement is made
to allow a suitable delay from the start of pumping
on each occasion, to take account of the time taken
for gas to reach the pellistor 7 from the atmosphere
100 to be monitored.
   Figure 2 shows the operating circuit for the
pellistor 7, which is arranged to be energised by a
battery 13 connectable between positive and nega-
tive supply terminals 14 and 15 by means of a switch
105 16. The voltage of the battery 13 is nominally 10
volts, but drops to about 8 volts as the battery 13
discharges in use. The pellistor 7 has its resistor 17
connected so as to form one arm AB of a bridge
network ABCD, the other arms BC, CD and DA of
110 which are respectively constituted by a resistor 18
(3.9 ohms), a resistor 19 (1 kilohm) and a resistor 20
(1 kilohm). The point A is connected to the terminal
15 and the point C is connected to the emitter of an
N-P-N transistor 21 (Type 2N3055), whose collector
115 is connected via a wirewound resistor 22 (4.7 ohms)
to the terminal 14.
   In order to control the current supplied to the
network ABCD from the battery 13 via the transistor
21, there is provided a servo loop comprising a
120 differential operational amplifier 23 (Type CA3130)
and a P-N-P transistor 24 (Type BFY70), the inverting
and non-inverting input terminals of the amplifier 23
being respectively connected to the point D and B,
the output terminal of the amplifier 23 being con-
125 nected to the base of the transistor 24 via a resistor
25 (10 kilohms) and a resistor 26 (1 kilohm) in series,
the emitter of the transistor 24 being connected
directly to the terminal 14, the base of the transistor
24 being connected to the terminal 14 via a resistor
130 27 (15 kilohms), and the collector of the transistor 24

being connected to the base and emitter of the transistor 21 respectively via a resistor 28 (51 ohms) and a resistor 29 (10 kiloms). The supply terminals of the amplifier 23 are respectively connected to the
5 terminals 14 and 15, and the input offset adjustment terminals of the amplifier 23 have connected between them a potentiometer 30 (100 kilohms) whose tapping point is connected to the terminal 15. The amplifier 23 also has a control terminal, connected to
10 an input line X, by means of which the amplifier 23 may be switched between its normal active state and a quiescent state, the former applying when the control terminal is left floating and the latter applying when it is connected to the terminal 15.
15 Capacitors 31 and 32 (both 330 picofarads) are respectively connected between the output terminal and the inverting input terminal of the amplifier 23 and between the control terminal and one of the input offset adjustment terminals of the amplifier 23,
20 in order to suppress any tendency for high frequency oscillations to occur.
The circuit also includes a P-N-P transistor 34 (Type BFY72) having its emitter connected to the terminal 14, its collector connected to the junction
25 between the resistors 25 and 26, and its base connected via a resistor 35 (4.7 kilohms) to the junction between resistors 36 and 37 (respectively 120 ohms and 560 ohms) which are connected in series across the resistor 22; as explained further
30 below, the function of this part of the circuit is to limit the current supplied to the network ABCD in a starting condition in which the pellistor 7 is being heated up to its desired operating temperature. A capacitor 38 (0.1 microfarads) connected between
35 the base of the transistor 34 and the terminal 14 serves a similar purpose to the capacitors 31 and 32. Finally, the circuit includes a potentiometer 39 (10 kilohms) connected between the points A and C and having its tapping connected to an output line Y.
40 Considering now the operation of the circuit shown in Figure 2, when the amplifier 23 is held in the quiescent state its output is switched off and the transistor 21 is accordingly maintained in a high impedance state; the network ABCD is then substan-
45 tially de-energised, so that the pellistor 7 is virtually unheated. When the amplifier 23 is in the active stage, a substantial current is supplied to the network ABCD via the transistor 21 so that the pellistor 7 is heated to the required operating
50 temperature. In this case the steady state condition of the system is such that, with the amplifier 23 working in a linear mode, the servo loop operates to vary the current supplied to the network ABCD, in response to the voltage appearing between the
55 points B and D, so as to maintain the resistance of the resistor 17 at a substantially constant value corresponding to the required operating temperature of the pellistor 7. The potentiometer 30 which constitutes the input offset control of the amplifier 23
60 is set so that in equilibrium the point B is held approximately 1 millivolt positive with respect to the point D, i.e. the controlled value of the resistor 17 is slightly greater than 3.9 ohms; this arrangement is preferable from the point of view of stability to one
65 involving precise balance of the network ABCD in

equilibrium. The operating temperature of the pellistor 7 is thus effectively determined by the values of the resistors 18, 19 and 20, and it is therefore important that these values should not be signifi-
70 cantly influenced by the value of the current supplied to the network ABCD; in particular, since the bulk of this current flows through the resistor 18 as well as the resistor 17, it is appropriate for the resistor 18 to be wound from wire having a low temperature
75 coefficient of resistivity and to be made physically large enough to ensure that its temperature in operation is not greatly above ambient temperature. It should be noted that in the steady state condition the operation of the servo loop is substantially
80 independent of the voltage of the battery 13 over the possible range of values of this voltage, and that in this condition the transistor 34 has no significant function since it is maintained in a high impedance state.
85 It will be appreciated that with the pellistor 7 maintained at a constant temperature there is a balance between the rate at which heat is lost from the pellistor 7 to its surroundings and the sum of the rates at which heat is absorbed by the pellistor 7
90 respectively as a result of the passage of current through the resistor 17 and as a result of any combustion of methane occurring on the catalyst material. It will thus be seen that, for a given rate of heat loss, in the steady state condition the value of
95 the current supplied to the network ABCD (and hence the value of the voltage appearing between the points A and C) varies inversely with the concentration of methane in the gas in the cavity 5; the variation is substantially linear over the range of
100 concentrations which the system is designed to measure. With the circuit components as quoted above the value of the voltage appearing between the points A and C in the steady state condition falls at the rate of approximately 100 millivolts for one per
105 cent increase in methane concentration; for zero methane concentrtion the value of this voltage is approximately 2.4 volts when the block 1 is at a temperature of 20°C. The value of the voltage appearing between the points A and C in the steady
110 state condition is utilised to provide a measure of methane concentration; how this is done, in a way providing a zero reference and temperature compensation, is described in detail below.
It is, however, appropriate first to consider the
115 operation of the circuit shown in Figure 2 in the starting condition which occurs when the amplifier 23 is switched from the quiescent state to the activity state. In this condition a substantial out-of-balance voltage rapidly appears between the points B and D.
120 (the resistance of the resistor 17 when unheated being about 1.3 ohms), so that the amplifier 23 is driven into a saturated condition. Accordingly the impedance of the transistor 21 is substantially lower, and the current supplied to the network ABCD is
125 substantially higher, than is the case for the steady state condition. This state of affairs holds until the pellistor 7 has virtually reached the required operating temperature, since the control range of the servo loop corresponds to a relatively narrow range of
130 values of the resistance of the resistor 17; the

pellistor 7 is thus heated up rapidly without any
asymptotic approach to the operating temperature
such as is encountered when using a standard
Wheatstone bridge arrangement. During this phase,
5 as the resistance of the resistor 17 increases, the
voltage between the points A and C increases
substantially linearly with time to reach a value
above that which it has in the steady state condition;
at the end of this phase the servo loop comes into its
10 normal mode of operation and brings the system
into the steady state condition with a slight further
delay (associated with thermal lag in the refractory
material of the pellistor 7) of somewhat less than 0.2
seconds. In the absence of countermeasures, the
15 length of the initial heating-up phase would vary
with changes in the voltage of the battery 13, which
would give rise to changes in the current supplied to
the network ABCD in this phase. Such an effect is
substantially eliminated by the action of the transis-
20 tor 34, which is operative in this phase to vary the
input to the transistor 24 in such a way as to prevent
the voltage appearing across the resistor 22 signifi-
cantly exceeding the value which it has when the
voltage of the battery 13 is at its minimum value.
25 With this arrangement, the length of the initial
heating-up phase is held substantially constant at
approximately 0.7 seconds so that a total time of less
than 0.9 seconds is required for the system to reach
the steady state condition after the amplifier 23 is
30 switched from the quiescent state to the active state.
The process is illustrated in Figure 3, which shows
the variation of the voltage (V) appearing between
the points A and C with the time (T) elapsed from the
switching of the amplifier 23; the solid and broken
35 curves at the right hand side respectively relate to
cases in which methane is absent from and present
in the gas in the cavity 5.
    Returning now to the question of obtaining a
measure of the methane concentration, in respect of
40 which one need consider only the steady state
condition, it will be apparent from what is said above
that changes in the rate of loss of heat from the
pellistor 7 will give rise to changes in the value of the
voltage appearing between the points A and C for a
45 given methane concentration. The principal factor
which may cause changes in the rate of heat loss is
the temperature of the block 1. Over the range of
values 0 - 40°C for this temperature it is found that
the variation of the voltage for a given methane
50 concentration is practically linear with a coefficient
of approximately −1.6 millivolt/°C; the total change
of voltage if the temperature varies over this range is
thus equivalent to a change of more than 0.6% in
methane concentration. If reliable measurements of
55 methane concentration are to be obtained therefore,
it is necessary either to maintain the temperature of
the block 1 substantially constant (which would
normally be impractical for an instrument for field
use) or to provide compensation for the effects of
60 variation of this temperature.
    The output voltage developed by the pellistor
operating circuit shown in Figure 2 (i.e. the voltage
appearing between the line Y and the terminal 15) is
of course directly proportional to the voltage appear-
65 ing between the points A and C, and its coefficient of

variation with the temperature of the block 1 is
likewise proportionately lower. Since the output
voltage has a non-zero value for zero methane
concentration it is appropriate (in order to obtain a
70 signal suitable for operating an indicating device) to
offset it with a reference voltage having a value
equal to the value of the output voltage for zero
methane concentration. It is then possible to provide
temperature compensation by arranging for the
75 reference voltage to vary in a similar manner to the
output voltage with changes in the temperature of
the block 1. Figure 4 shows a circuit by means of
which such a reference voltage is generated. The
circuit comprises a resistor 40 (4 kilohms) and a
80 reference device 41 (Type ZN458) which has a
negligible temperature coefficient, connected in
series between the terminals 14 and 15; connected
across the device 41 is the series combination of a
potentiometer 42 (5 kilohms), whose tapping is
85 connected to an output line Z, and the silicon diode
12 (see Figure 1). With this arrangement the voltage
appearing across the combination of the compo-
nents 42 and 12 is held substantially constant at 2.5
volts, regardless of changes in the voltage of the
90 battery 13 and the ambient temperature; the voltage
appearing across the diode 12 varies with the
temperature of the block 1, the value for a tempera-
ture of 20°C being 0.7 volts and the temperature
coefficient being approximately −2 millivolts/°C over
95 the range 0 − 40°C. The reference voltage generated
by the circuit (i.e. the voltage appearing between the
line Z and the terminal 15) can thus be chosen, by the
setting of the potentiometer 42, to have any value
between 0.7 to 2.5 volts when the temperature of the
100 block 1 is 20°C; if the chosen value is denoted by V_R
volts, the coefficient of variation of the reference
voltage with the temperature of the block 1 is
approximately equal to $-2(2.5 - V_R)/1.8$ millivolts/
°C. On the other hand the corresponding coefficient
105 for the output voltage of the pellistor operating
circuit is approximately equal to $-1.6 V_o/2.4$ milli-
volts/°C, where V_o volts is the value of the output
voltage for zero methane concentration when the
temperature of the block 1 is 20°C. Obviously, the
110 potentiometers 39 and 42 must be set so that $V_R =$
V_o, but this can be satisfied for any value between
0.7 and 2.4. It is therefore possible to impose an
additional condition on the potentiometer settings
such that the temperature coefficients of the output
115 and reference voltages are made equal; from the
expressions quoted above it can readily be seen that
when both conditions are met V_o and V_R will be
approximately 25/16. Precise matching can of course
be achieved by setting the potentiometers 39 and 42
120 empirically for a specific system, but it will normally
be possible to achieve a sufficient degree of temper-
ature compensation by choosing the settings in
accordance with assumed typical values for the
temperature coefficients of the diode 12 and the
125 voltage appearing between the points A and C;
when using such values, it would of course also be
possible to replace the potentiometers 39 and 42 by
appropriately proportioned potential dividers consti-
tuted by fixed resistors. It will be appreciated that,
130 with the potentiometers 39 and 42 set as described

above, the difference between the output and reference voltages will be a voltage whose magnitude is directly proportional to methane concentration, substantially unaffected by changes in the temperature
5 of the block 1 over the range 0 - 40°C.

It should be noted that the rate of loss of heat from the pellistor 7 is also liable to be affected by changes in the thermal conductivity of the gas in the cavity 5, but the magnitude of any error due to this cause is
10 normally within an acceptable tolerance for accuracy of the measurement of methane concentration. The most significant factor affecting the thermal conductivity is likely to be the relative humidity of the atmosphere being monitored; it is therefore normal-
15 ly appropriate to base the calibration of the system (in respect of the precise value of the voltage appearing between the points A and C which is taken to correspond to zero methane concentration) on air with a relative humidity of 50%.
20 Figure 5 illustrates the overall electrical arrangement of the system, with the circuits shown in Figures 2 and 4 respectively constituting the components designated 43 and 44. Each measurement operation is initiated by a pulse derived from a pulse
25 generator 45. In an instrument for "continuous" monitoring, the generator 45 is free running so as to generate a regularly recurrent train of pulses, suitably with a repetition period of 10 seconds or more; in a portable instrument for making spot tests, the
30 generator 45 is operable manually to generate a single pulse whenever a measurement is required. The output of the generator 45 is applied to the set terminal of a bistable latch 46 and to the input of a delay circuit 47 designed to give a delay of 0.9
35 seconds. The latch 46 controls the operation of a switching circuit 48, which in its closed state connects the line X of the circuit 43 to the terminal 15 to hold the amplifier 23 in the quiescent state; operation of the latch 46 by the pulse from the generator
40 45 opens the switching circuit 48 and thus switches the amplifier 23 into the active state. The circuit 43 then operates as described above, with the steady state condition being reached before the delayed pulse appears at the output of the circuit 47. The
45 output of this circuit is applied to trigger a further pulse generator 49, which generates a first pulse of duration 0.1 seconds and a second pulse immediately following the first. The first pulse from the generator 49 is utilised to operate a sample-and-hold
50 circuit 50 connected to the output of the circuit 43, so as to obtain the value of the output voltage required for the measurement; between successive operations of the generator 49, the output of the circuit 50 of course remains substantially constant at the last
55 sampled value. The second pulse from the generator 49 is applied to the rest terminal of the latch 46, causing the switching circuit 48 to close so that the amplifier 23 reverts to the quiescent state. It will thus be seen that for each measurement operation a
60 significant current is drawn from the battery 13 for only 1 second. The outputs of the sample-and-hold circuit 50 and the reference circuit 44 are applied to a subtraction circuit 51, the output of which provides a signal indicative of methane concentration, this
65 signal can of course be used for indication or control

purposes either locally or at a remote station. In a portable instrument the circuit 51 may suitably be replaced by a digital voltmeter incorporated in the instrument and arranged to respond to the differ-
70 ence between the outputs of the circuits 50 and 44.

In some cases a requirement may arise for a gas detection system of the kind specified by means of which there can be made two different types of measurement requiring the use of significantly diffe-
75 rent operating temperatures for a catalytic sensing element. The system described above with reference to the drawings can readily be modified to meet such a requirement without any need for duplication of the pellistor operating circuit. A suitable arrange-
80 ment would involve the provision of a means for automatically switching the resistance in the arm BC of the bridge network so that the resistance is maintained at lower and higher values respectively during first and second phases of each measure-
85 ment operation, and the addition of a second sample-and-hold circuit connected to the output of the pellistor operating circuit; the arrangement would of couse be such that during the first phase one sample-and-hold circuit is operated after the
90 system has reached a steady state condition with the pellistor at the lower of the two operating temperatures, and that during the second phase the other sample-and-hold circuit is operated after the pellistor has been further heated up and the system has
95 reached another steady state condition with the pellistor at the higher operating temperature. The outputs of the two sample-and-hold circuits could then be utilised, either singly or in an appropriate combination, to provide measurement signals; in a
100 portable instrument it would be convenient to provide a single meter to which the measurement signals could be selectively applied at the choice of the operator.

105 CLAIMS

1. A gas detection system of the kind specified, in which said thermally sensitive resistor is connected in a resistive bridge network arranged to be supplied
110 with current whose value is set by a control means which can assume either a first state such that sufficient current is supplied to the network to cause the sensing element of the system to be heated to an elevated operating temperature or a second state
115 such that the network is substantially de-energised, the control means being operative in said first state so that the system has a steady state condition in which the value of the current is automatically controlled by the control means, in response to a
120 feedback signal derived from the network, so as to maintain the resistance of said resistor substantially constant, the system comprising means for causing the control means to change from said second state to said first state and to revert to said second state
125 after a period during which the system will reach a steady state condition, means for deriving from the network an output voltage whose value when the system is in said steady state condition is dependent on the value of the current supplied to the network,
130 and means for obtaining a measurement by virtue of

the sampling of said output voltage during the part
of said period when the system is in said steady state
condition.

    2.   A gas detection system according to Claim 1,
5 in which said means for obtaining a measurement
includes means for comparing the sampled value of
said output voltage with referencwe voltage derived
from a circuit which includes a semiconductor diode
disposed so as to be exposed to the temperature of
10 the surroundings of the sensing element, the diode
having a temperature coefficient such that unwanted
variation of the value of said output voltage when
the system is in said steady state condition, resulting
from changes in the temperature of said surround-
15 ings, is compensated for by corresponding variation
in the reference voltage.

    3.   A gas detection system of the kind specified, in
which said thermally sensitive resistor is connected
in a resistive bridge network arranged to be supplied
20 with sufficient current to cause the sensing element
of the system to be heated to an elevated operating
temperature, the system comprising a control
means which is operative so that the system has a
steady state condition in which the value of the
25 current is automatically controlled by the control
means, in response to a feedback signal derived
from the network, so as to maintain the resistance of
said resistor substantially constant, means for deriv-
ing from the network an output voltage whose value
30 when the system is in said steady state condition is
dependent on the value of the current supplied to the
network and hence is subject to unwanted variation
as a result of changes in the temperature of the
surroundings of the sensing element, and means for
35 obtaining a measurement by virtue of the compari-
son of said output voltage with a reference voltage
derived from a circuit which includes a semiconduc-
tor diode disposed so as to be exposed to the
temperature of said surroundings, the diode having
40 a temperature coefficient such that said unwanted
variation in respect of said output voltage is com-
pensated for by corresponding variation in the
reference voltage.

    4.   A gas detection system of the kind specified,
45 substantially as hereinbefore described with refer-
ence to the accompanying drawings.